Space Weather Technical Forecast

Issued on Tuesday 1 October 2024 at 01:18 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-flares (R1-R2 Blackouts). Chance of G1-G2/Minor-Moderate Geomagnetic storms day 1.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity is Moderate with one M7.8 class flare peaking at 30/2359UTC.

There are currently ten sunspot regions on the visible disc. The most notable remains AR3842 in the southeast quadrant, which continues to show growth within the intermediate spot structure, now with several spots joining into the main leader, with at least two delta regions now present here. AR3843 is the second largest group and shows minor growth. AR3840 has re-emerged in the northwest. All other spots remain relatively benign.

A CME observed leaving the Sun around 30/1545UTC may give a glancing blow on day 3 (03 Oct).

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of a weak coronal hole fast wind. Slightly elevated through the period though they have eased back from around 475 km/s to near 400 km/s. Density was mostly below average values. Interplanetary Magnetic Field, Bt, started moderate, with a peak of 12nT at 30/0001 UTC, before declining to background levels below 8nT. The north-south started the period moderately negative (southward) between until 30/0100 UTC before easing to weak values below +/-8nT. Phi angle was predominately negative (towards the Sun). Geomagnetic activity was mostly Quiet (Kp1-2), with one Unsettled (Kp3) interval 30/0000-0300UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels (at diurnal peak), with a peak value of 212 pfu at 30/1750 UTC. The associated 24-hour fluence was below the Active threshold. The 01/0000 UTC observation was 4.38e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a chance of further isolated M-class flares. There is a very slight chance of an isolated X-class flare, mostly likely from AR3842.

Solar Wind / Geomagnetic Activity: A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been reanalysed with possible glancing impacts at Earth any time from early day

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2 (01 Oct) until early day 3 (02 Oct). A further CME which left the Sun around 30/1545 UTC may give a glancing blow early on day 3 (03 Oct), both of these CME arrivals are low confidence with and impact likely to be weak. Without any CME influences Solar winds are likely to return to background levels on day 1 (01 Oct).

Mainly Quiet (Kp 0-2) geomagnetic conditions are expected initially, with a chance of Unsettled to Active (Kp 3-4) intervals due to the waning coronal hole fast wind environment. There is then a chance of G1-G2/Minor-Moderate geomagnetic storms occurring day 1 (01 Oct) due to the glancing arrival of the 29 Sep CME, this risk continuing but reducing into day 3 (03 Oct). Confidence becomes lower by day 4 (04 Oct) due to the number of filaments currently on the disc and uncertainty regarding CME arrival times.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background. High energy electron flux at GOES16 is expected to persist at Background, with an increasing chance of Moderate to High. The associated 24 hour fluence is expected to initially remain below the Active threshold (1e8 total pfu), though with decreasing certainty.

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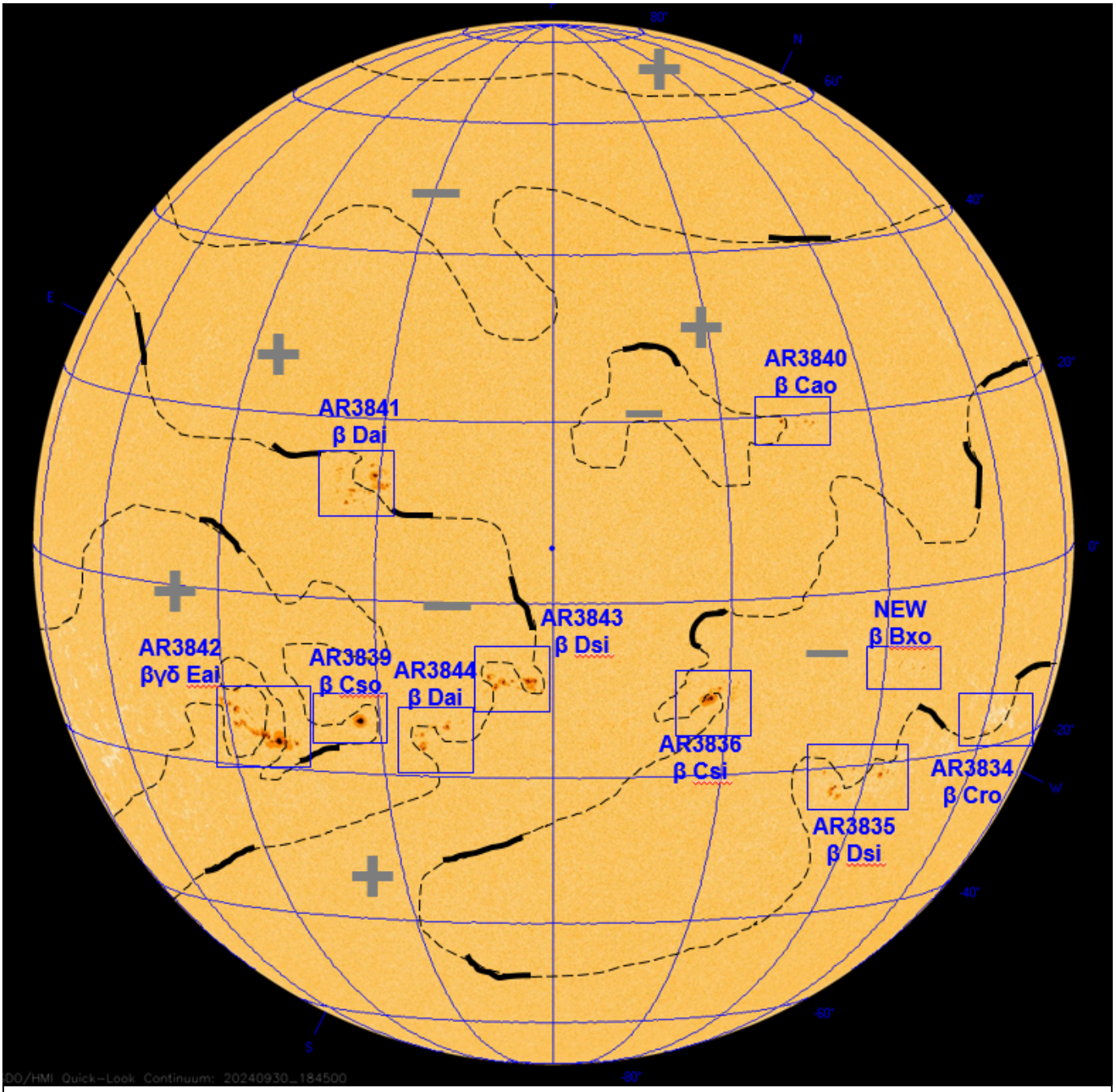
Figure 1: Solar Analysis Vt 30/1900 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been reanalysed with possible glancing impacts at Earth early day 1 (01 Oct), but with low confidence in the speed due to lack of STEREO A imagery meaning that this CME may be slower than anticipated, perhaps with delayed effects starting on day 2 (02 Oct). Although the bulk of the CME will miss ahead of Earth's orbit, glancing impacts are now considered possible. A further CME was observed leaving the Sun around 30/1545 UTC, this fast CME will mostly miss Earth however there is a small chance of a glancing blow on the day 3 (03 Oct).

Solar wind speeds have been at slightly elevated levels through the period, though have eased back from around 475km/s to just above 400km/s as the effects of CH76/- wane. In the absence of any CME, solar wind speeds should trend back to background through the period. Currently wind speeds in MOSWOC Enlil are too high due to Enlil vastly overestimating the longevity of the current coronal hole fast wind. After the recent reanalysis of the 29 Sep CME, MOSWOC Enlil and Enlil ensemble are now displaying an increased risk of a glancing blow from this feature at Earth.

Mainly Quiet (Kp 0-2) geomagnetic conditions are expected initially, with a chance of Unsettled to Active (Kp 3-4) intervals due to the waning coronal hole fast wind environment. There is then a chance of G1-G2/Minor-Moderate geomagnetic storms occurring day 1 (01 Oct) due to the glancing arrival of the 29 Sep CME, this risk continuing but reducing into day 3 (03 Oct). Confidence becomes lower by day 4 (04 Oct) due to the number of filaments currently on the disc, as any disruption could result in an Earth-directed CME, and a subsequent increase in geomagnetic activity is possible later in the period.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	30	20	20	10
Strong	G3	No	1	1	1	0
Severe	G4	No	1	1	1	0
Extreme	G5	No	1	1	1	0

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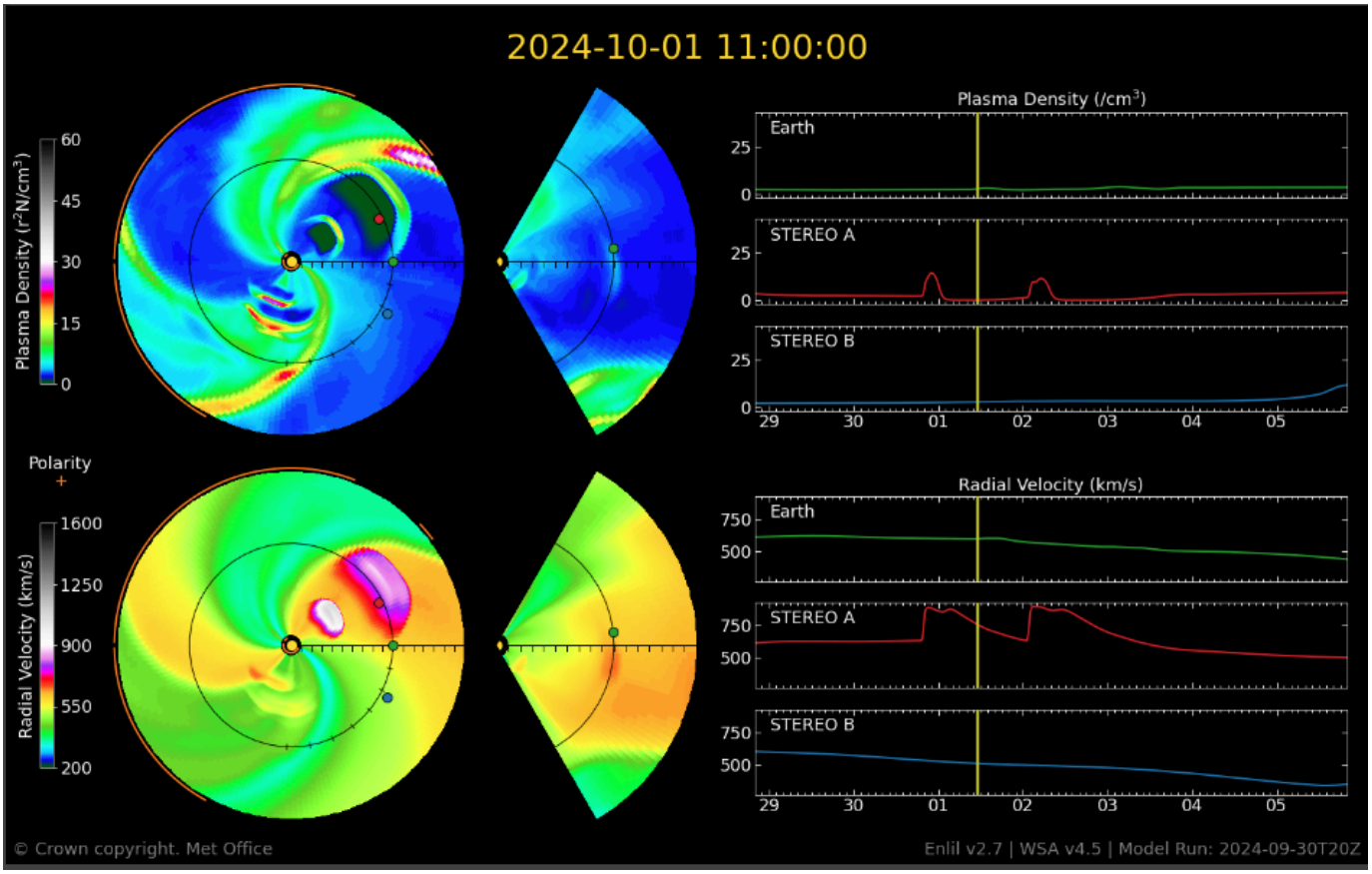
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
29/0901	Partial	AR3834	SW	1200	01/0900UTC	Glancing blow. Low confidence.
30/1545	Partial	Filament	SW	1500	03/0300UTC	Glancing blow. Low confidence.

Figure 2: MOSWOC Enlil shows a pair of CMEs mostly ahead of Earth but glancing blows are possible



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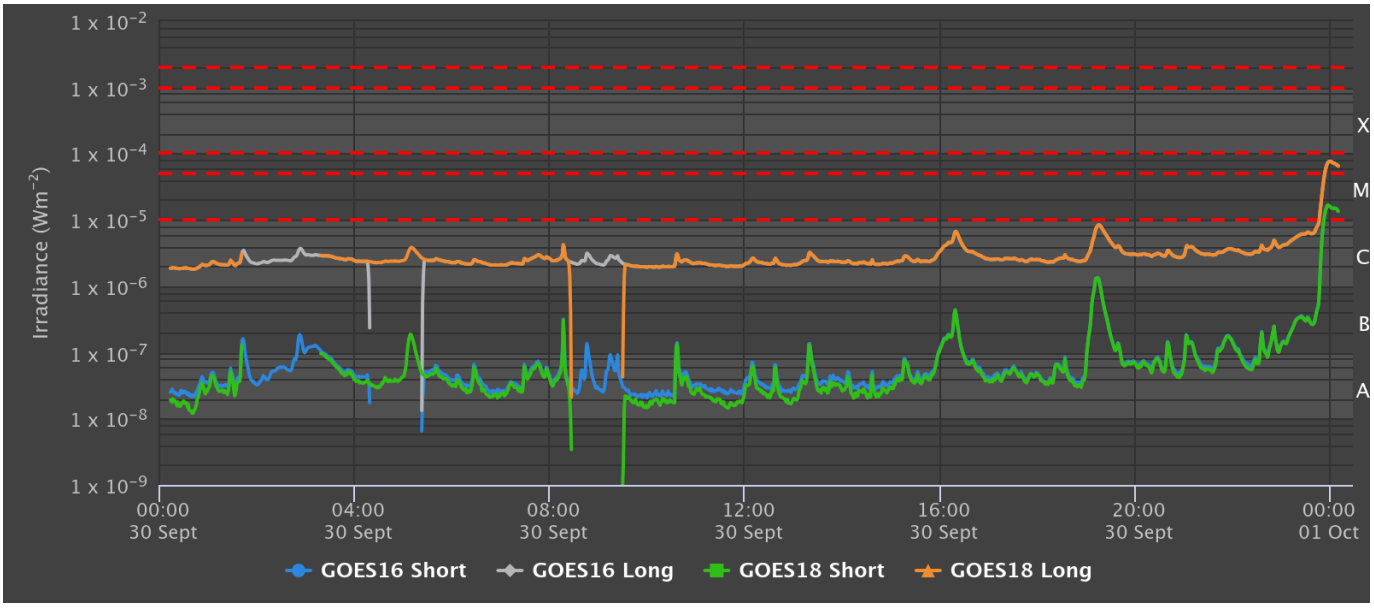
Radio Blackouts - X-Ray Flares

Low to Moderate activity is forecast with an ongoing chance of further isolated M-class flares. There is a slight chance of X-class flares

There are currently ten sunspot regions on the visible disc. The most notable remains AR3842 in the southeast quadrant, which continues to show growth within the intermediate spot structure, now with several spots joining into the main leader, with at least two delta regions now present here. AR3843 is the second largest group and shows minor growth. AR3840 has re-emerged in the northwest. All other spots remain relatively benign.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	60	50	50	50
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: GOES18 X-Ray flux



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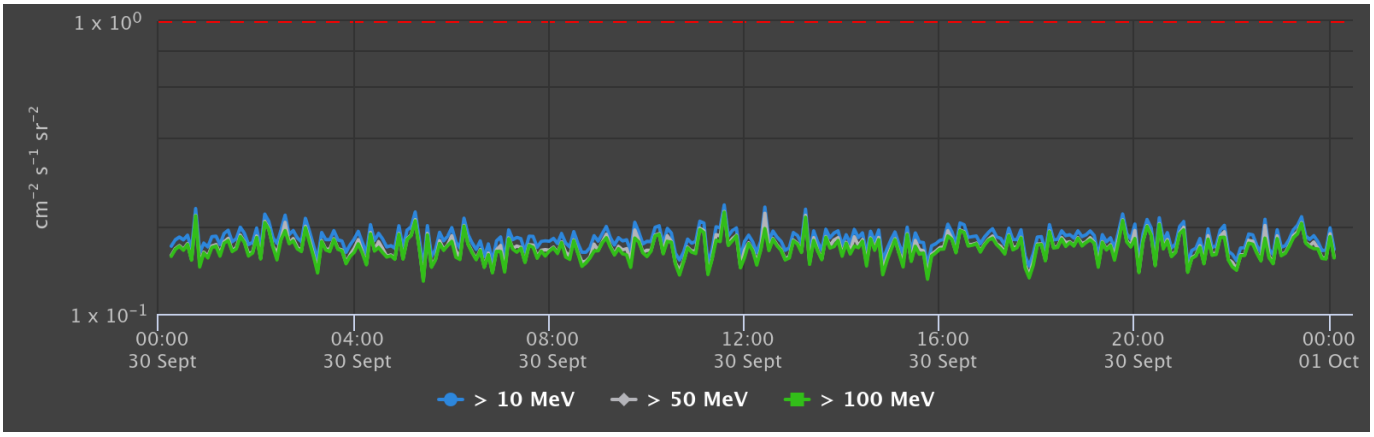
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels. Many of the current visible sunspots are generally small and simple providing only modest contributions to flare risk, and are unlikely to significantly impact proton flux at Earth. However, the chance of Proton rich flares increases as AR3842 rotates closer to centre disk by day 2 (02 Oct). Also, given the number of notable filaments currently on the disc, there is also a very low, albeit non-zero chance of observable protons should any significant filament eruption occur during the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES16 Proton Flux



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels (at diurnal peak). Electrons are expected to remain at background levels after the recent arrival of a fast wind from CH76/-, which should keep them suppressed in the short-term. A recovery to Moderate or perhaps briefly High levels (at diurnal peak) is likely towards the end of the period.

The associated 24 hour fluence is forecast to stay below Active (1e8 total pfu), in agreement with MOSWOC REFM, although a slight increasing trend is likely towards the end of the period, but is still expected to remain below the Active threshold.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^8	No	1	5	10	15
Very Active	≥ 2 MeV ≥ 1×10^9	No	1	1	1	1

Figure 5: GOES16 Electron Flux

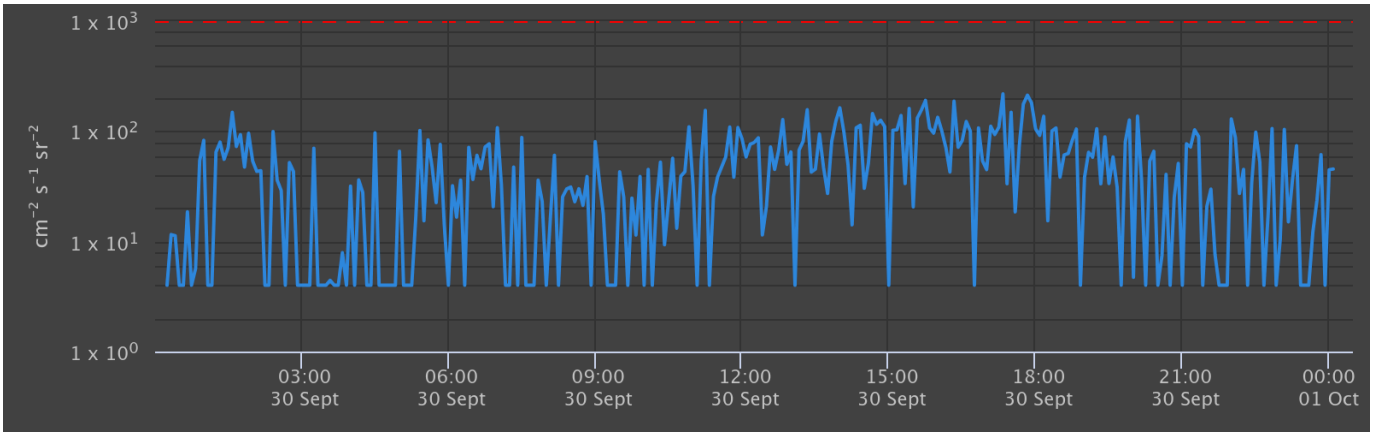

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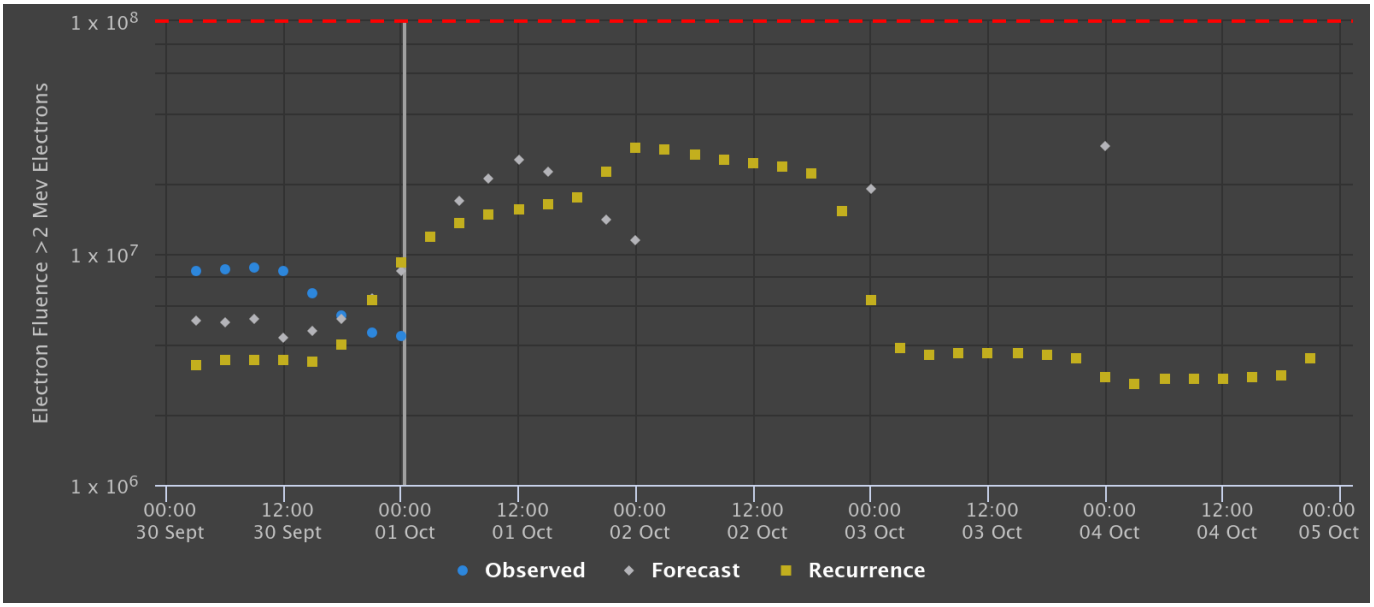
Figure 6: MOSWOC REF Model



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